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Root Proliferation of Triticum Aestivum In Different Soil Profiles

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Abstract

Wheat is the dominant crop in temperate countries being used for human food and livestock feed. Its success depends partly on its adaptability and high yield potential. Wheat also contributes essential amino acids (lysin, threonine, valine, proline, alanine, cysteine and histidine), minerals (selenium, manganese, phosphorus, copper and folate),vitamins(thiamin, niacin, pyridoxine) beneficial phytochemicals and dietary fibre components to the human diet. The soils in Rajsthan are mostly sandy, alkaline, chalky, and saline. Other types of soils found in Rajsthan are loamy,clay,nitrogenous soil and the black lava soil. This experiment was conducted to study the root growth of wheat grown in different soil profiles. Seeds of wheat (*Triticum aestivum)* variety "K8804" were grown under three differently treated soils in a soil culture system. Wheat seedlings were grown in normal soil, Sodium hydroxide treated soil (sodic) and Sodium chloride treated soil (saline) and maintained regularly over 50 days for observing the effect on germination and root growth of wheat. Roots of *Triticum aestivum* were extracted out from soil and many parameters were observed during the experiments like seed germination, root lenth, root weight, root density, root surface, stem lenth and dry mass of roots. Seedlings root traits of wheat (*Triticum aestivum)* have been shown to be important for efficient establishment and linked to mature plant traits such as height and yield. Root length, root weight, root density, root surface area were highest in normal followed by sodic and saline portions of lateral and vertical splits of salt profiles. Root penetration was much inhibited by salinity as well as saline and sodic soils when used separately as sole growth medium had adverse effects on growth but sodic soil decidedly proved less harmful than saline soil when these two separately formed the bottom layer of salt profile with normal on the top.

Keywords: Wheat (Triticum Aestivum), Root Growth, Salinity, Soil Alkality

Introduction

Wheat is the most important crop which account for about 60% of world's human energy requirement. In India as well as in Himachal Pradesh these are the major food grain crop. In India total area under wheat is 26.99 million hectares with production of 91.79 million tones and 72.14 million tones of respective crops. Wheat occupies first position in acreage, covering about 369.8 thousand hectares. Limited availability of additional land for crop production, with declining factor productivity of major food crop are the major concerns of feeding a world population expected to exceed 7.5 billion by the year 2020. Wheat is the second most produced crop on Earth, lagging behind only corn. Wheat provides a large fraction of the dietary protein and total food supply, and is grown all throughout the world in wide variety of climates. Wheat is a staple crop, grown as a primary food product and for other use.

The production and productivity of wheat crop were quite low when India becomes independent in 1947. The production of wheat was only 6.46 million tones and productivity was merely 663 kg per hectare. The possibility of increasing the wheat production in India , wheat scientists introduced five dwarf wheat varieties viz, Lerma Rojo 64-A, Sonora 63, Sonora 64, Mayo 64, S 227. India has exported about 30 Lakh tones of wheat.

Wheat is grown in all the states in India except Southern and North Eastern states. Utter Pradesh, Haryana, Punjab, Rajasthan are the major wheat producing states and accounts for almost 80% of total production in India. Only 13% area is rain fed. Major rain fed wheat areas are in Madhya Pradesh, Gujarat, Maharashtra, West Bengal and Karnataka. Central and Peninsular Zone accounts for total 1/3rd of wheat area in India.

Materials and Methods

Geographical location

The field experiment was conducted at Chittorgarh district in Rajasthan. Chittorgarh located in the Southern part of the state of Rajasthan 233km from Ajmer midway between Delhi and Mumbai on the National Highway 8 (India). The elevation of Chittorgarh is 394 m (1,293 ft). Chittorgarh located between 23° 32' and 25° 13' north latitudes & between 74° 12'and 75° 49' east longitudes in the southeastern part of Rajasthan state.

Climate and Weather

The climate of Chittorgarh is quite dry and parched. The summer season extends from April to June and is quite hot. The average temperature in summers falls between 43.8°C – 23.8°C. May and June are considered the hottest month of the year when temperature reaches 45°C. The city gets very little rainfall during the season

Soil characteristics

Soil was collected from the field. The collected soil was black soil. Black soil was usually black because they are high in organic matter. They often form in grasslands and wetlands. Organic matter contains plant nutrients and it also improves the physical properties of the soil enhancing it for the growth of plant.

Physiochemical analysis of soil-

Estimation of pH

The prepared solution of soil: water in 1:2 ratio (25 gm of soil+ 50 ml distilled water) is filled in beaker and checked the pH of the solution by using pH meter. The value is shown on the pH meter is the pH of the soil.

Estimation of electrical conductivity

EC (Electrical conductivity of soil paste extract) - The prepared solution (25 gm of soil+ 50 ml distilled water) is filled in glassware and now check the EC of the solution. The value is shown on the EC meter is the Electrical conductivity of soil paste extract.

Experimental details

Experiments were conducted in plastic pots at the National Research centre on seed spices, Ajmer during May June month of 2015 in totally laboratory conditions. Three types of soil viz. normal, saline and sodic were used as growing media for plants. Normal soils collected from Bojunda, Dhanet, Kapasan villages in Chittorgarh district, brought to the laboratory and used as such (Table 1). For saline and sodic treatments the normal soil was treated with NaCl and NaOH solutions (Richard, 1954).

All the types of soil were adequately fertilized with N P K before use. In all 9 treatments, singly and in combinations of normal, saline and sodic soils were vertically and laterally simulated. Variations in lateral salt profiles were achieved by partitioning a given pot into two equal compartments through longitudinally inserting a removable steel septum after soil filling (Fig. 4). Treatments were replicated three times.

Twenty to twenty five healthy seeds of semi dwarf wheat K8804 were sown at a depth of 2 cm in each pot at an interval of 3 cm in a single row across the diameter on 17th May. Pots were watered as and when needed throughout the experiment. Germination counts were noted 7 days after sowing and expressed as percentage of seeds sown. For root separation, the whole soil lumps along with roots and plants intact were taken out of the pots by allowing them roll down laterally. Either entire root systems of whole soil lumps or lateral or vertical splits of salt profiles were first separated by cutting with a sharp implement and washed separately with forced tap water. Excess water was removed from roots by blotting papers. Linear root growth also termed as root penetration was measured from the base of the shoot to the tip of the longest root recovered after washing. Root volume was determined by immersing roots in a given volume of water in a measuring cylinder. Root surface area was obtained by multiplying the total root length to root circumference assuming that entire root system was of uniform thickness. Root density was defined as root dry weight present in a given spilt of salt profile. Dry weight of roots was determined by drying them at 80º C for 24hours.

A pot was filled with Normal Treated Soil (500 ml Distilled Water + Soil). For saline treatment the normal soil was treated with NaCl solutions. 10gm of NaCl was added to 250 ml of distilled water in a beaker and stirred. Then that prepared solution was mixed into with normal soil. Then a pot was filled with that NaCl treated soil. For sodic treatment the normal soil was treated with NaOH solutions. Pellets of NaOH was added to 250 ml of distilled water in a beaker and stirred till it dissolves completely. Then that prepared solution was mixed into another amount of soil. Then another pot was filled with that NaOH treated soil.

Three pots were taken containing holes. In the first pot, half pot was filled with Normal treated soil and remaining half pot was filled with NaCl treated soil horizontally. Then in the second pot, half of the pot was filled with Normal treated soil and another half portion was filled with NaOH treated soil horizontally. In the last third pot, half of the pot was filled with NaOH treated soil and another half portion was filled with NaCl treated soil horizontally (Fig. 1).

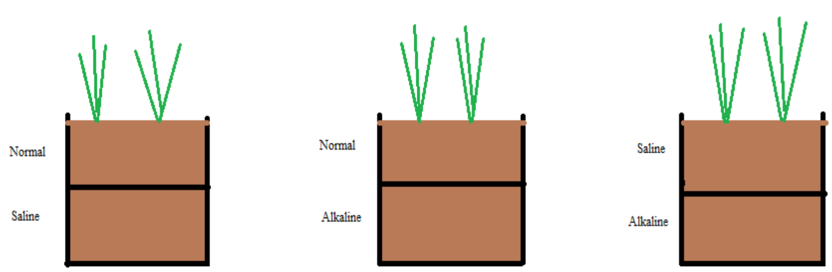

Fig. 1 Soil profile arrangement of normal and alkaline soil

Another three pots were taken containing holes. In the first pot, half pot was filled with Normal treated soil and remaining half pot was filled with NaCl treated soil vertically. Then in the second pot, half of the pot was filled with Normal treated soil and another half portion was filled with NaOH treated soil vertically. In the next pot, half of the pot was filled with NaCl treated soil and another half portion was filled with NaOH treated soil vertically (Fig. 2).

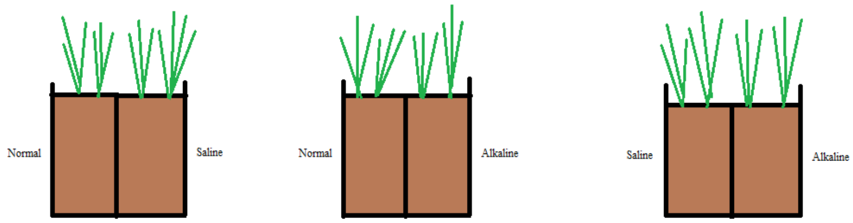

Fig. 2 Soil profile arrangement of Normal, saline and alkaline soil

Results and Discussion

Under adverse soil conditions germination was delayed and reduced in saline and sodic situations. Interestingly, the deleterious effect of salts was much less on plant survival than on germination of seeds. This may be due to adaptation of growing wheat plants to adverse soil conditions (Bonehert *et al*., 1995). Germination and plant survival were not affected by salininty and sodicity when they formed the bottom layer of salt profile and affected only slightly when they formed lateral variation with normal soil. This may have been due to the fact that seeds and subsequently growing plants might not have come in direct contact of adverse soil conditions for quite some time under the former treatments whereas under latter situations salinity or sodicity being very close to seeds and plants might have exerted their harmful influence to some extent (Tripathi *et al.,* 2017).

Root length, root weight, root density, root surface area were highest in normal followed by sodic and saline portions of lateral and vertical splits of salt profiles. Root penetration was much inhibited by salinity. Inhibition by salinity of root growth has earlier been reported in several field crops (Wadlegh *et al.*, 1947; Sharma *et al.*, 1984). It has been a direct effect on the cells of root tips which may limit their growth and penetration. The increasing osmotic potential of the substrate reduces the permeability of the roots to water and this condition may result in a slight dehydration of the cell wall membranes (Dwivedi *et al*., 1981; Mansour and Lee- Stadelmann, 1993). Saline and sodic soils when used separately as sole growth medium had adverse effects on growth but sodic soil decidedly proved less harmful than saline soil when these two separately formed the bottom layer of salt profile with normal on the top.

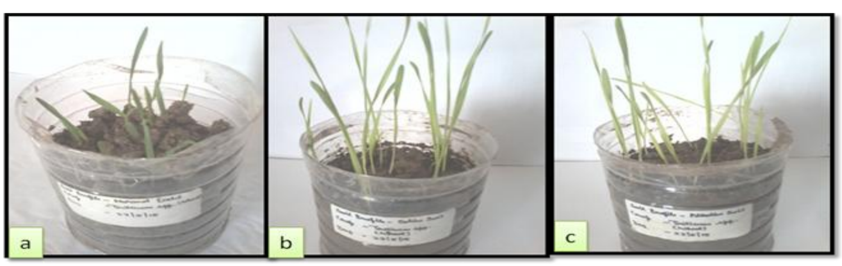

Fig. 3 Prepared pot of Soil profile

(a- normal soil, b- saline soil treatment, c- sodic soil treatment)

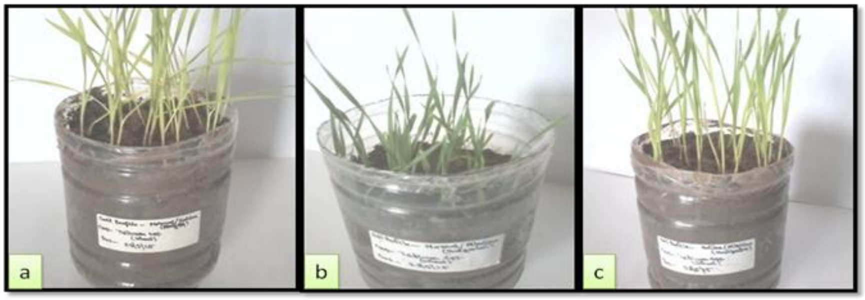

Fig. 4 Prepared pot of Soil profile [a- Normal/saline soil (Horizontal), b- Normal/Sodic soil (Horizontal), c- Saline/Sodic soil (Horizontal)]

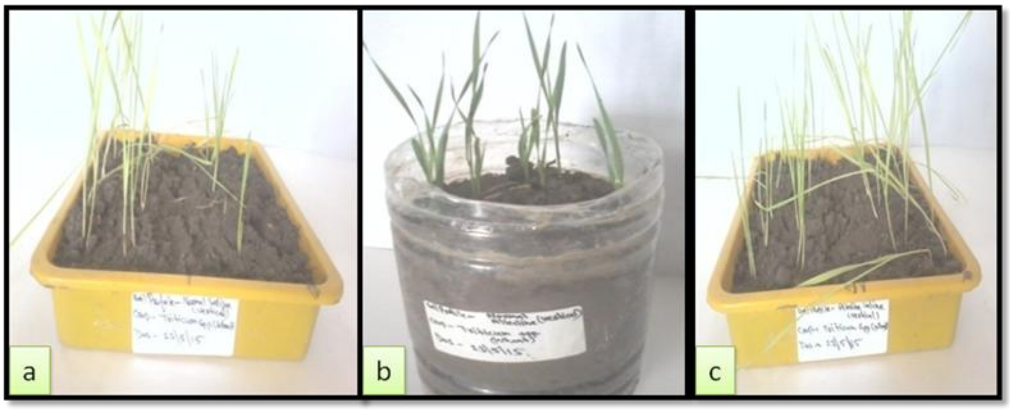

Fig. 5 Prepared tray of [a- Normal/saline soil (Vertical), b- Normal/Sodic soil (Vertical), c- Sodic/saline soil (Vertical)]

Fig. 6 Wheat root growth normal soil, sodic soil, saline soil.

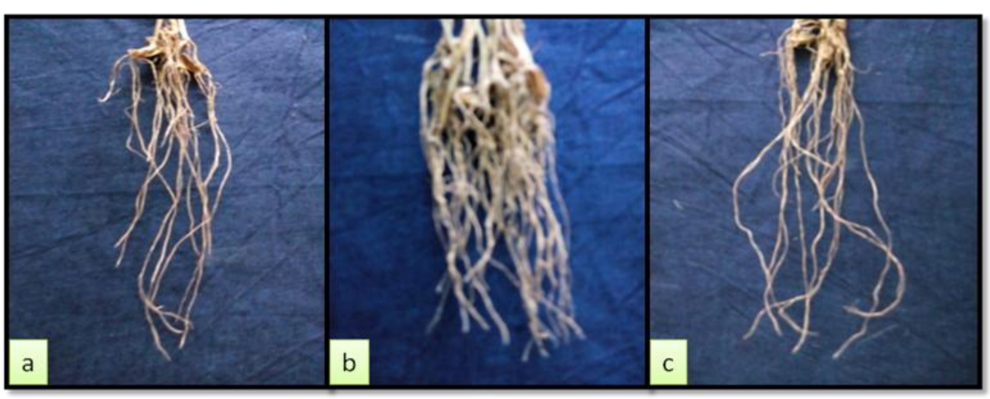

Fig. 7 Wheat root growth [a- Normal/ saline soil (Horizontal), b- Normal /sodic soil (Horizontal), c-Saline/ Sodic soil (Horizontal)]

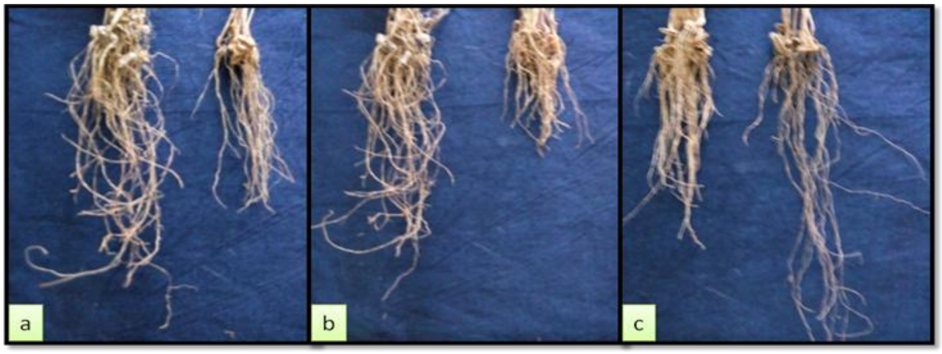

Fig. 8 Wheat root growth [a-Normal/saline soil (Vertical), b- Normal/ sodic soil (Vertical), c- Sodic /saline soil (Vertical)]

Table 1 Physiochemical analysis of experimental soil.

S. No.	**Soil Profile**	**pH**	**EC (dS/m)**
1	Normal	7.3	2.3
2	Saline	7.4	15.2
3	Sodic	9.6	3.5

Table 2 Wheat root growth & penetration in variable salt profile in soil.

S. No.	**Treatment**	**Date of sowing**	**Seed no. of sowed**	**No of germinated seeds**
1	Normal	17-5-2015	20	14
2	Saline	17-5-2015	20	16
3	Sodic	17-5-2015	20	19
4	Normal/Saline(Horizontal)	17-5-2015	24	24
5	Normal/Sodic(Horizontal)	17-5-2015	24	21
6	Saline/Sodic(Horizontal)	17-5-2015	22	22
7	Normal/Saline(Vertical)	17-5-2015	Nor-20	Nor-18
			Sal-20	Sal-14
8	Normal/Sodic(Vertical)	17-5-2015	Nor-16	Nor-12

			Sod-14	Sod-10
9	Sodic/Saline(Vertical)	17-5-2015	Sod-24	Sod-21
			Sal-22	Sal-14

Nor= Normal soil, Sod= Sodic soil, Sal= Saline soil

Table 3 Analysis of wheat stem length & root dry weight as affected by vertical & lateral variation salt profile in soil.

S. No	Treatment	Split of salt profile	Stem Length (cm)	Root Length (cm)	Root Density (gm)
1	Normal	Upper half normal/Lower half normal	0.7	10.76	4.5
2	Saline	Upper half saline/Lower half saline	0.9	9	2.14
3	Sodic	Upper half sodic/Lower half sodic	0.8	12.57	1.89
4	Normal/Saline (Horizontal)	Upper half normal/Lower half saline	1.06	8.1	3.16
5	Normal/Sodic (Horizontal)	Upper half normal/Lower half sodic	0.5	7.25	2.62
6	Saline/Sodic (Horizontal)	Upper half saline/Lower half sodic	1.45	8.745	2.2
7	Normal/Saline (Vertical)	Half normal/ Lower saline	Nor-0.72 Sal-0.1	Nor-5.625 Sal-4.22	3.34
8	Normal/Sodic (Vertical)	Half normal/ Lower sodic	Nor-0.6 Sod-0.25	Nor-5.72 Sod-6.33	2.78
9	Sodic/Saline (Vertical)	Half sodic/ Lower saline	Sod-1 Sal-0.2	Sod-6.35 Sal-5.75	1.9

N= Normal, Sod= Sodic soil, Sal= Saline soil

Conclusion

Soil salininty and sodicity is a matter of global concern for stepping up agricultural production. Differential salt profiles were simulated in potted soil to study their effects on root growth and the yield of Wheat. The root length, root volume and root surface area greatly decreased under saline (EC 15.2dS/m) as well as sodic (pH9.6) soil conditions. In a vertically variable profile with top soil normal with lower one saline; the root penetration was poor as compared to the one having top soil normal with lower one sodic. However, root growth differences were not so prominent when normal/ saline or normal/ sodic soil variations were in lateral plane. The biomass positively correlated with root dry weight which, in turn, was dependent upon soil chemical environment. It is concluded that the salinity of simulated sub- soil was more detrimental to plant growth than the sodicity of similar zone.

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